

## Barkerville Terrane, Cariboo Lake to Wells: A New Look at Stratigraphy, Structure and Regional Correlations of the Snowshoe Group

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**KEYWORDS:** *Barkerville Terrane, Snowshoe Group, Downey succession, Bralco limestone, Hardscrabble Mountain succession, Harveys Ridge succession, Agnes conglomerate, Goose Peak succession, Kootenay Terrane, nappe, gold, besshi.*

### INTRODUCTION

The area underlain by the Barkerville Terrane has an important exploration and mining history dating from the discovery of placer gold on Keithley Creek in 1860. Placer gold production peaked in the 1860s, but continues at a modest scale to the present time. Lode gold production came mainly from the Wells mining camp, located near some of the richest placer streams in the district, between 1933 and 1987. The more recent discoveries of the Ace and Frank Creek occurrences near Cariboo Lake has attracted attention to the massive sulphide potential of the Barkerville Terrane, whereas the discovery of high-grade gold mineralization within the Bonanza Ledge zone in March 2000 rejuvenated interest in the lode-gold potential of the Wells mining camp.

The BC Geological Survey Branch conducted regional mapping programs near Cariboo Lake in 2000 and 2001 (Figure 1), directed mainly at examining the stratigraphic and structural setting of massive sulphide mineralization within the Snowshoe Group of Barkerville Terrane (Ferri, 2001; Ferri and O'Brien, 2002). This work led to a revised interpretation of the Snowshoe Group stratigraphy that had previously been established by Struik (1988). The purpose of the 2002 Barkerville bedrock mapping project, reported on here, was to evaluate this revised stratigraphic interpretation farther north, with the aim of providing a better framework for evaluating the potential of individual units within the Snowshoe Group to host precious or base metal mineralization. This mapping project is a P3 partnership with International Wayside Gold Mines Limited, who are conducting a major exploration program for gold mineralization in the Wells-Barkerville area.

The 2002 mapping program was carried out from July 9 to September 7. An area of about 600 km<sup>2</sup>, including portions of NTS sheets 93A/13 and 14 and 93H/3 and 4, was covered, but much of this was at reconnaissance scale (Figure 1). More detailed coverage was obtained in a relatively small area (100 km<sup>2</sup>) extending from Jack of Clubs Lake southeastward to Grouse Creek. This area encompasses the

Barkerville gold belt of Hanson (1935), and provided insights into correlations between the detailed stratigraphy that Hanson established within this belt and the regional stratigraphy of the Snowshoe Group. Furthermore, this area provides juxtaposition of three units within the Snowshoe Group (Harveys Ridge, Downey and Hardscrabble Mountain) whose mutual relationships are critical and contradictory in the stratigraphic schemes of Struik (1988) *versus* Ferri and O'Brien (2002).

The 2002 map area is located near the north end of the Quesnel Highlands, an area of moderate relief bounded by the Interior Plateau to the west and the rugged Cariboo Mountains to the east. Fieldwork was conducted from a base in the town of Wells, located along Highway 26 about 75 kilometres east of Quesnel. Forest Service, logging and mining roads, as well as historic mining trails and modern snowmobile and ski trails, provide good access to much of the eastern part of the map area. Access to the northern part of the area is from logging and mining roads along Lightning and Peters creeks, which extend southward from Highway 26 west of Wells. The Swift River Forest Service Road branches southward from Highway 26 about 25 kilometres east of Quesnel, and provides access to the western part of the area via major logging road networks that extend up Fontaine Creek and the Little Swift and Swift rivers.

### REGIONAL GEOLOGIC SETTING

Barkerville Terrane is represented mainly by the Snowshoe Group, a package of predominantly siliciclastic rocks with local intercalations of carbonate and metavolcanic rocks. It was defined by Struik (1986, 1988) who correlated it with the Kootenay Terrane of southern British Columbia. These Hadrynian and Paleozoic rocks display some similarities to strata of the North American miogeocline, but differ in the presence of Paleozoic grit, volcanic and intrusive rocks, and local indications of Paleozoic deformation and metamorphism, not evident in age-equivalent rocks to the east. They are generally interpreted as an outboard facies of the North American continental margin (eg. Struik, 1987; Colpron and Price, 1995).

Barkerville Terrane is contacted to the east by a succession of Hadrynian through late Paleozoic clastic sedimentary rocks and carbonate represented mainly by the Kaza, Cariboo and Black Stuart groups. These rocks are assigned to the Cariboo Terrane (Figure 1; Struik, 1986). They are at



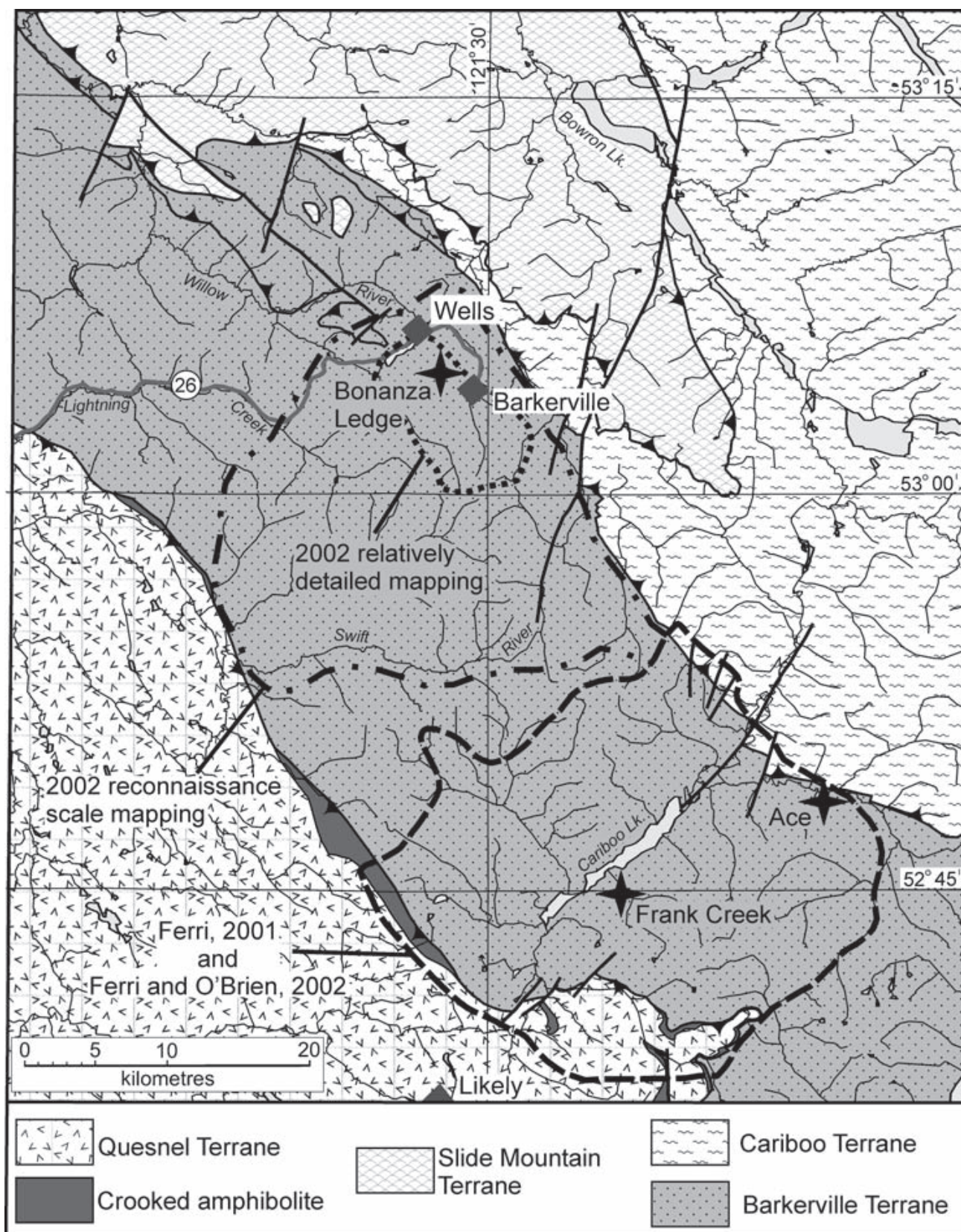


Figure 1. Simplified terrane map of the Cariboo Lake - Wells area, showing areas mapped by the B.C. Geological Survey Branch in 2000 through 2002.



least partially age-equivalent to rocks of the adjacent Barkerville Terrane, but contain facies that suggest a more proximal continental shelf setting. The two terranes are separated by the east-dipping Pleasant Valley thrust fault (Struik, 1986).

East of Wells, the Cariboo Terrane is structurally overlain by oceanic rocks of the Slide Mountain Terrane, represented by Lower Mississippian to Lower Permian basalt and chert of the Antler Formation. The Antler Formation is internally thrust-imbricated (Struik and Orchard, 1985), and is separated from the underlying Cariboo Terrane by the gently-dipping, presumably east-directed Pundata thrust fault. The age of the Pundata thrust is not well constrained, but thrust-imbrication and emplacement of the Slide Mountain Terrane elsewhere in the region has been interpreted to be a Permo-Triassic event (Schiarizza, 1989; Ferri, 1997). To the northwest of Wells, the western boundary of the Antler allochthon also overlaps the eastern edge of Barkerville Terrane (Figure 1). This relationship can be interpreted to reflect fault juxtaposition of Barkerville and Cariboo terranes prior to emplacement of the Antler allochthon (Struik, 1986, 1988). However, a similar geometry could result from early emplacement of the Antler allochthon above Cariboo Terrane, followed by west-directed thrusting of Cariboo above Barkerville Terrane, provided the Pleasant Valley thrust cut up-section in its hangingwall through the Pundata thrust and into the Antler Formation.

The Barkerville Terrane is bounded to the west by the Quesnel Terrane, represented mainly by Middle Triassic to Lower Jurassic arc-derived sedimentary, volcanic and intrusive rocks (Struik, 1988; Panteleyev *et al.*, 1996). The contact is the predominantly west-dipping Eureka thrust fault. Slivers of ultramafic rock, gabbro, amphibolite and ocean-floor basalt that occur along this thrust fault are assigned to the Crooked amphibolite unit; these rocks have been correlated with the Slide Mountain Terrane and inferred to represent part of the basement to the Quesnel volcanic arc (Rees, 1987; Struik, 1988).

Studies along the western edge of the Barkerville Terrane document Early to Middle Jurassic east-directed thrusting of Quesnel Terrane above Barkerville Terrane along the Eureka thrust fault, followed by southwest-vergent folding of the terrane boundary (Ross *et al.*, 1985; Brown *et al.*, 1986; Rees, 1987). This deformation was accompanied by amphibolite to greenschist facies metamorphism. The metamorphic peak was attained prior to (Fillipone and Ross, 1990) or during (Rees, 1987) the southwest-directed folding, and is dated as Middle Jurassic on the basis of a  $174 \pm 4$  Ma U-Pb age on metamorphic sphene from near Quesnel Lake (Mortensen *et al.*, 1987). Similar southwest-vergent, synmetamorphic folds are prominent structural features throughout much of Barkerville, Kootenay and western Cariboo terranes (Raeside and Simony, 1983; Schiarizza and Preto, 1987; Murphy, 1987; Struik, 1988; Ferri and O'Brien, 2002), and are constrained or interpreted to be of late Early to Middle Jurassic age (Murphy *et al.*, 1995; Colpron *et al.*, 1996). Younger folds within Barkerville Terrane are upright to

northeast or southwest-vergent, and mainly late to post-metamorphic (Rees, 1987; Struik, 1988; Ferri and O'Brien, 2002). However, studies within and adjacent to the southern Cariboo Mountains, near the Barkerville/Cariboo terrane boundary, indicate that structures which postdate the major southwest-vergent folding there are associated with a younger metamorphic event of Early Cretaceous age. (Currie, 1988; Digel *et al.*, 1998; P.S. Simony, personal communication, 2002).

Among the youngest structures in the region are orogen-parallel dextral strike-slip faults and related folds that are documented within the Cariboo Mountains east of Barkerville Terrane (Reid *et al.*, 2002). These structures are thought to be Late Cretaceous to Eocene in age, and thus coeval with other major dextral strike-slip fault systems in the Canadian Cordillera (Struik, 1983; Umhoefer and Schiarizza, 1996).

## HISTORY OF NOMENCLATURE

The first major study of bedrock geology in the region was by Bowman (1889) who assigned rocks presently included in Barkerville terrane to the Cariboo schists. Johnston and Uglow (1926) mapped the Barkerville area and subdivided the Cariboo Series into several formations. Hanson (1935) mapped the area between Island Mountain and Grouse Creek, referred to as the Barkerville gold belt for its numerous lode-gold occurrences, in more detail. This belt is underlain mainly by Johnston and Uglow's Richfield Formation, which Hansen subdivided into the Baker, Rainbow, B.C., Lowhee and Basal members; these names are still widely used in the Wells mining camp. Lang (1938) mapped farther to the south and presented a different subdivision of the Richfield Formation as well as several new formation names. Holland (1954) mapped the Yanks Peak and Rountop Mountain areas, changed Cariboo Series to Cariboo Group and introduced new formation names that completely revised the stratigraphy of the group. This revised stratigraphy included the Snowshoe Formation, named for the Snowshoe plateau of the Quesnel Highlands, as the upper formation of the group. Sutherland Brown (1957) extended Holland's Cariboo Group terminology northward to Wells, completely replacing the terminology of Johnston and Uglow (1926) and Hanson (1935), and then eastward, far into the Cariboo Mountains (Sutherland Brown, 1963).

The Cariboo Group of Holland (1954) and Sutherland Brown (1957, 1963) encompassed rocks of both the Cariboo Mountains and Quesnel Highlands. Campbell *et al.* (1973) suggested that some formations assigned to the group in the Quesnel Highlands might not be equivalent to formations with the same name in the Cariboo Mountains. They also suggested that the Snowshoe Formation, interpreted as the uppermost formation of the Cariboo Group in the Quesnel Highlands, might actually be equivalent to the Kaza Group, which underlies the Cariboo Group in the central Cariboo Mountains. These questions were addressed in subsequent regional mapping programs undertaken by L.C. Struik of the Geological Survey of Canada. Struik (1986,

1987, 1988) concluded that the Quesnel Highlands stratigraphy was indeed different from that in the Cariboo Mountains. He retained the term Cariboo Group, as well as most of the original formational names (excluding Snowshoe Formation) for the stratigraphic succession of the Cariboo Mountains, and coined the term Cariboo Terrane for the larger package of rocks, or facies belt, that contains the group. Struik assigned most of the Quesnel Highlands succession to the Snowshoe Group, and introduced the name Barkerville Terrane for the facies belt that includes the group.

## LITHOLOGIC UNITS

### SNOWSHOE GROUP

#### Overview

Struik (1988) assigned most rocks of the Barkerville Terrane to the Snowshoe Group. He subdivided the Snowshoe Group into 14 informal units, allowing that some of the units might be lateral equivalents. Struik considered the lower part of the group to be Hadrynian and higher stratigraphic units to be Paleozoic, possibly extending into the upper Paleozoic. His distribution of stratigraphic units defined a general younging from southwest to northeast across the Barkerville Terrane.

Ferri (2001) and Ferri and O'Brien (2002) proposed major revisions to Struik's stratigraphic interpretation based on their mapping of the Snowshoe Group near Cariboo Lake (Figure 1). They suggested that the Ramos succession along Keithley Creek was actually part of the Keithley succession and, most importantly, that these Keithley plus Ramos rocks correlated with the Downey succession, which formed much of the eastern edge of the Barkerville Terrane. They also suggested that the Harveys Ridge and Hardscrabble Mountain successions were correlative. These correlations reduced that number of stratigraphic units within the Snowshoe Group by about 50 percent (Figure 2), and implied major stratigraphic repetitions across the Snowshoe belt.

Observations made during the 2002 field season were generally consistent with the revised stratigraphic interpretation of Ferri and O'Brien (2002). Specifically, rocks mapped as Harveys Ridge succession east of Cariboo Lake (Struik, 1988; Ferri and O'Brien, 2002) were traced northwestward to the Barkerville area, where they interfinger with rocks of the Hardscrabble Mountain succession. The Harveys Ridge and Hardscrabble Mountain successions therefore appear to be part of the same stratigraphic unit, and relationships in both the southern (Ferri and O'Brien, 2002) and northern (Struik, 1988; this study) parts of this belt indicate that this unit rests structurally beneath the Downey succession to the east across an overturned stratigraphic contact. Further corroboration comes from the western part of the study area, where the north-western extension of the belt mapped as Keithley and Ramos by Struik (1988), but correlated with the Downey succession by Ferri and O'Brien (2002), was found to com-

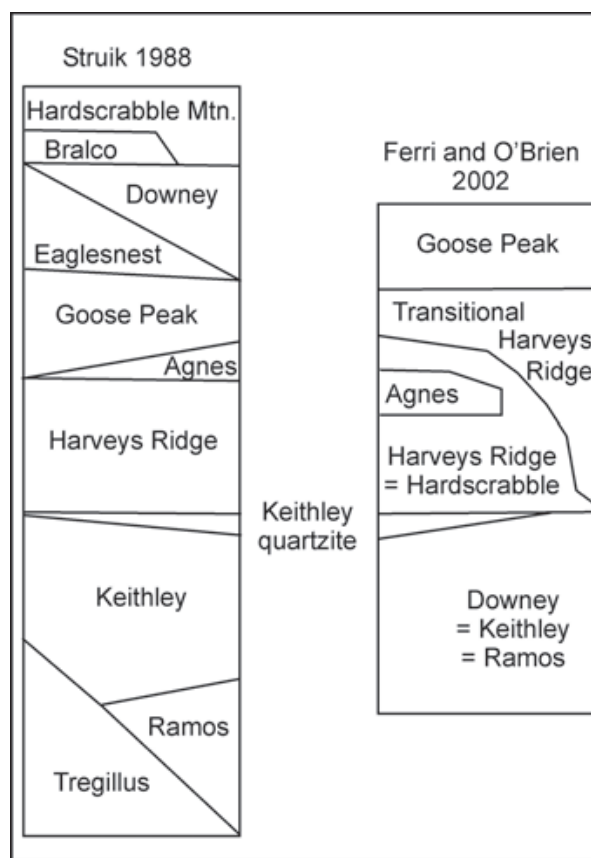


Figure 2. Stratigraphic charts comparing the Snowshoe Group stratigraphy defined by Struik (1988) and the revised interpretation suggested by Ferri and O'Brien (2002).

prise rocks that are lithologically identical to those of the Downey succession.

The stratigraphy of the Snowshoe Group in the Cariboo Lake – Wells area, as interpreted in this study, is summarized in Figure 3, and the generalized distribution of map units within the group is shown in Figure 4. Correlation of the Downey succession with the Keithley and Ramos successions requires a major structural repetition across the area, which we attribute to a large southwest-vergent nappe that has subsequently been folded across the upright Lightning Creek antiform. The axial trace of this late antiform separates the area into a northeast domain of mainly northeast-dipping strata and a southwest domain of mainly southwest-dipping strata (Figure 5). Individual map units within the Snowshoe Group are discussed in the following sections.

### DOWNEY SUCCESSION AND CORRELATIVE ROCKS

Rocks assigned here to the Downey succession crop out in two belts on opposite sides of the Lightning Creek antiform (Figure 4). Both belts are flanked by younger rocks on either side, and are therefore inferred to core isoclinal anticlines; in the interpretation preferred here these are different parts of the same anticline folded across the

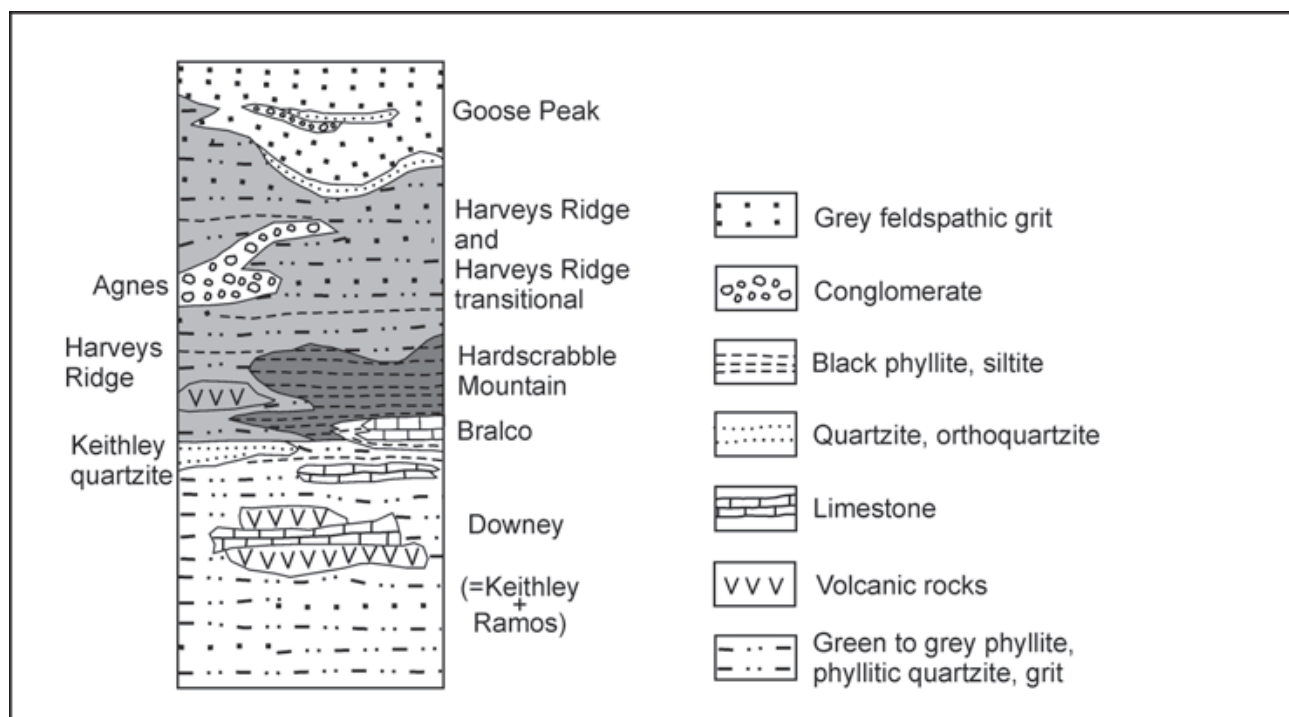


Figure 3. Generalized stratigraphic column summarizing the stratigraphy of the Snowshoe Group in the Cariboo Lake – Wells area, as interpreted in this study.

Lightning Creek antiform (Figure 5). The eastern belt, extending from the east end of Cariboo Lake to Wells, comprises the Downey succession as defined and mapped by Struik (1988). The southern end of the western belt includes rocks assigned to the Keithley and Ramos successions by Struik (1988), which were remapped and tentatively correlated with the Downey succession by Ferri and O'Brien (2002). The northern part of the western belt includes rocks assigned to the Keithley succession and undifferentiated Snowshoe Group by Struik (1988). These rocks were examined during the 2002 field season and are included in the Downey succession on the basis of their lithologic similarity to the eastern belt of Downey rocks. Higher grade metasedimentary and metavolcanic rocks that occur above the Keithley thrust, west of Keithley Creek, are also assigned to the Downey succession following Ferri and O'Brien (2002).

The Downey succession is in part characterized by mafic metavolcanic rocks and limestone that are not common within other parts of the Snowshoe Group. However, the unit is dominated by phyllites, siltites, phyllitic quartzites and phyllitic grits that resemble rocks in many other units of the group. The most common lithology is pale to medium green to grey-green phyllite and silty phyllite that typically displays a distinct silvery sheen on cleavage surfaces. Coarser grained phyllitic quartzite and grit are also common. These may occur as distinct thin to thick beds intercalated with phyllite, or as intervals many tens of metres thick in which bedding is not easily discerned. These coarser rocks, like the associated phyllites, are com-

monly green to grey-green in colour. In places, however, and particularly near the top of the succession, they are light to medium grey and associated with medium grey to black phyllite, in which case they are not distinct from quartzites and grits found in the Harveys Ridge transitional or Goose Peak successions. Relict detrital grains in the quartzites and grits are mainly clear, grey or blue quartz, but may include up to several percent feldspar.

Massive, mainly light grey quartzite to orthoquartzite forms the top of the Downey succession (formerly Keithley succession) in the vicinity of Yanks Peak, and along strike to the northwest, on the north side of the Swift River. This quartzite is referred to as the Keithley quartzite by Struik (1988). Similar relatively pure quartzite forms the top of the Downey succession in exposures east of Cariboo Lake, forming part of the rationale for correlating the Downey and Keithley successions (Ferri, 2001; Ferri and O'Brien, 2002).

Light to medium grey, commonly orange, brown or dark-grey weathered limestone is a subordinate but distinctive component of the Downey succession. In the eastern belt good exposures are found near Cunningham Creek, along lower Lowhee Creek and on the lower slopes west of Cow Mountain. Ferri and O'Brien (2002) identified limestone within the western belt, in rocks previously mapped as Ramos succession along upper Keithley Creek, and limestone was encountered farther to the north, along the Swift River, during our 2002 mapping program. The limestone within the Downey succession forms massive to well-bedded units ranging from a few metres up to many



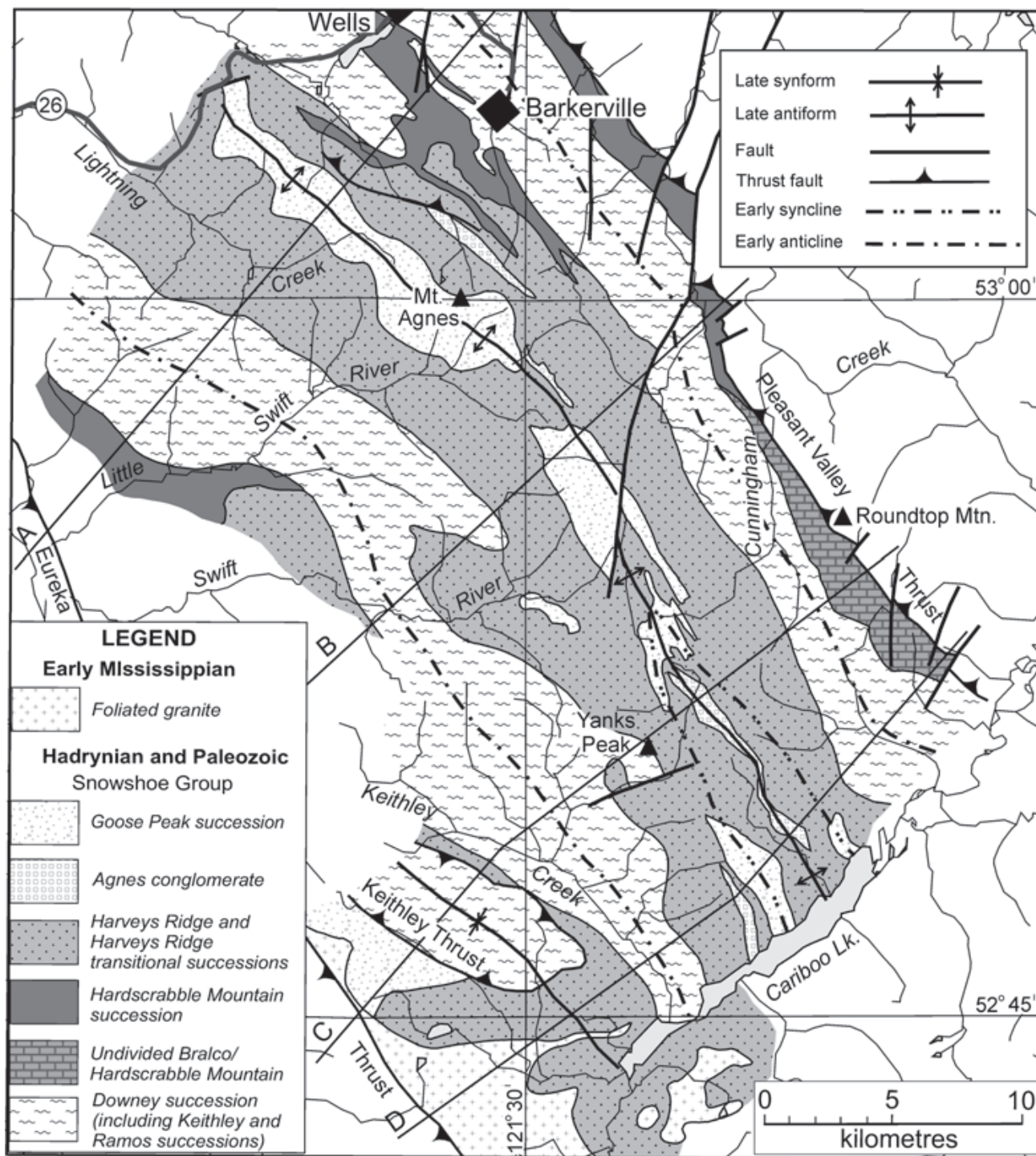


Figure 4. Generalized geology of the Cariboo Lake - Wells area, based on the work of L.C. Struik (1984, 1988), Ferri and O'Brien (2002) and this study.

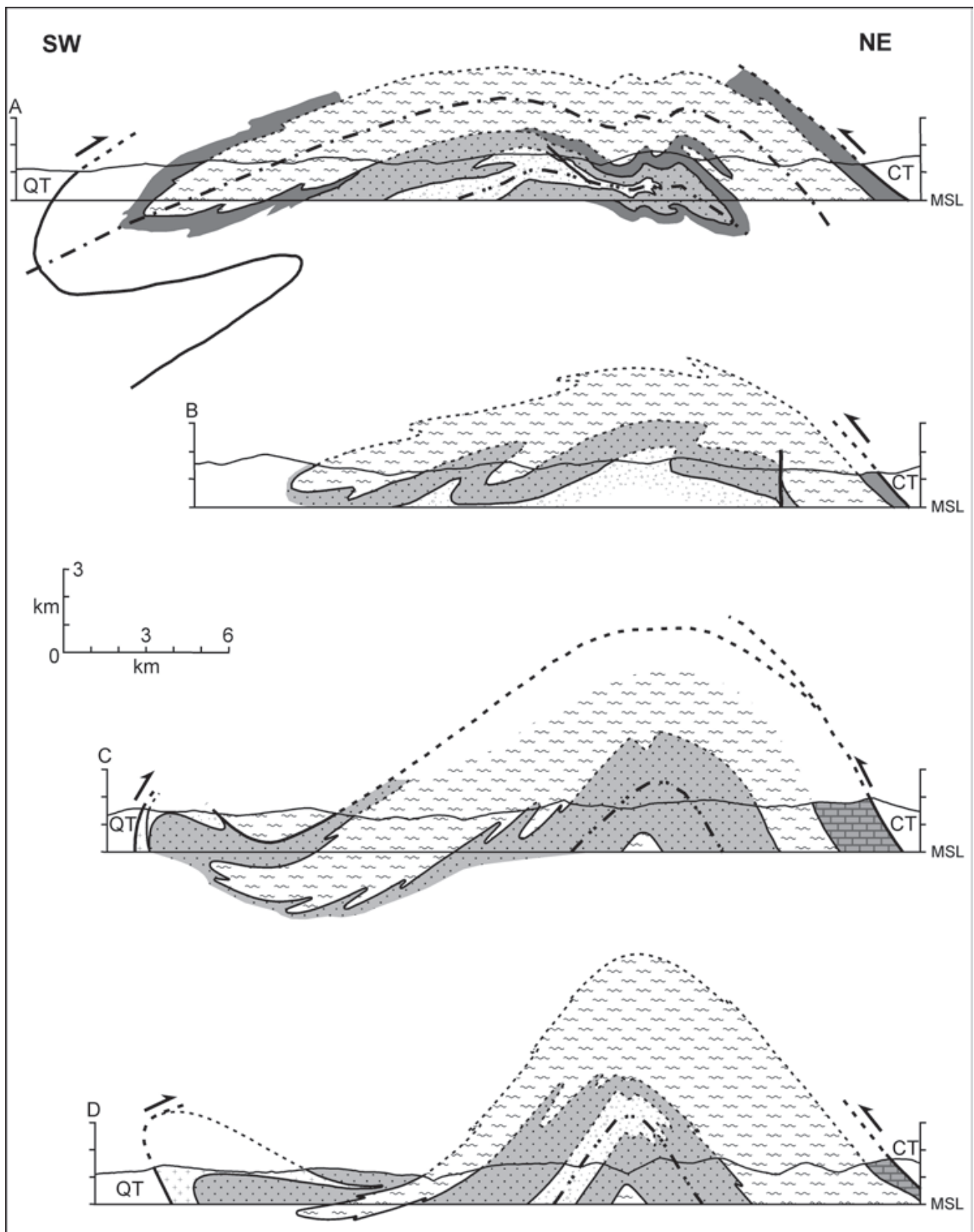


Figure 5. Schematic vertical cross sections illustrating the main structural features of the Snowshoe Group, as interpreted in this study. Cross section lines and legend are shown in Figure 4. Sections C and D are from Ferri and O'Brien (2003). CT = Cariboo Terrane, QT = Quesnel Terrane.

tens of metres thick. These limestone units are in part intercalated with clastic rocks typical of the Downey succession, although immediately adjacent phyllites and quartzites are in many places distinctly calcareous. Commonly, however, limestone occurs in sections that include abundant chloritic phyllite of probable volcanic or volcanoclastic origin.

The thickest section of mafic volcanic and volcanoclastic rocks known within the Downey succession occurs in the Mount Barker area, east of Cariboo Lake and south of the present study area. There, Ferri (2001) describes chloritic schists and bedded mafic tuffs, intercalated with limestone, phyllite and quartzite, that are the dominant lithology over a stratigraphic interval of several hundred metres near the structural base (stratigraphic top) of the Downey succession. Ferri and O'Brien (2002) traced this interval northwestward across the Cariboo River to Simlock Creek, where it is represented by less than 100 metres of chlorite schist structurally overlain by interbedded limestone and phyllite. Still farther along strike to the northwest, along Cunningham Creek, chlorite phyllite occurs as several narrow units, each less than ten metres thick, intercalated with quartzite, phyllite and limestone over a stratigraphic interval that may be several hundred metres thick. Chlorite phyllite was noted at a number of widely scattered localities elsewhere within both eastern and western Downey belts but, with the exception of a thick mafic package included in the Downey succession above the Keithley thrust (Ferri and O'Brien, 2002), does not appear to constitute a major proportion of the succession. Furthermore, although a mafic igneous origin is reasonably inferred, most exposures do not display relict textures that demonstrate a volcanic or volcanoclastic origin; it is possible that a significant proportion are derived from intrusive rocks associated with younger foliated dioritic bodies that are common within the Downey succession (described in a later section).

Struik (1988) considered the Downey succession to be Paleozoic. Fossils collected from limestone tentatively included in the Downey succession north of Wells indicate a Paleozoic, probably Late Cambrian or younger, age. However, the fossils were collected from a fault panel along the Pleasant Valley thrust fault that is not in continuity with the main belt of Downey rocks. This panel is only tentatively assigned to the Downey succession (Struik, 1988), and therefore the fossils may not provide a valid age constraint for the unit.

## **HARDSCRABBLE MOUNTAIN SUCCESSION**

The Hardscrabble Mountain succession consists almost entirely of black siltite and phyllite that is here considered to be a fine-grained facies within the Harveys Ridge succession (Figure 3). It is best exposed in the Wells - Barkerville area, where it flanks the Downey succession to both the northeast and southwest (Figure 4). Most of these rocks were also mapped as Hardscrabble Mountain succession by Struik (1988), although he included part of the southwestern belt in the Harveys Ridge succession. The

Hardscrabble Mountain succession is also mapped as a belt that crosses the Little Swift River along the western boundary of the map area. These rocks are structurally above the Downey succession on the southwest flank of the western Downey belt. They were mapped mainly as Harveys Ridge succession by Struik (1988).

Bedding/cleavage relationships, fold asymmetry and sedimentary tops indicators in both Downey and Hardscrabble Mountain successions west of Barkerville and Wells, where the Downey is structurally above the Hardscrabble Mountain, indicate that this contact is overturned and the Hardscrabble Mountain succession is stratigraphically above the Downey succession (Benedict, 1945; Alldrick, 1983; Struik, 1988; this study). South and west of Barkerville, both along and across strike, the fine-grained rocks of the Hardscrabble Mountain succession interfinger with, and eventually become a subordinate facies within, a succession dominated by medium to dark grey quartzites and gritty quartzites assigned to the Harveys Ridge succession (Figure 4). The Hardscrabble Mountain succession has a greater strike-length on the northeast flank of the Downey succession, but there its stratigraphic top is not seen because it is structurally overlain by the Pleasant Valley thrust.

The most common lithology within the Hardscrabble Mountain succession is dark grey to black siltite that occurs as thin to locally medium beds separated by partings or thin films of black phyllite. The siltite commonly contains thin bedding-parallel laminae of white quartz. In places black siltite is intercalated with planar to wavy laminae or very thin beds of light to medium grey siltite to very fine-grained quartzite. Elsewhere, the unit consists mainly of well-foliated black phyllite.

## **BRALCO LIMESTONE**

A prominent limestone unit that occurs stratigraphically above the Downey succession along the western edge of the Barkerville Terrane between Cunningham Creek and the north arm of Quesnel Lake is referred to as the Bralco limestone by Struik (1988). At the north end of this belt the Bralco is repeated several times across northeast-dipping thrust faults and associated folds (Struik, 1988) and is structurally interleaved with black phyllite, and locally pale green phyllite and phyllitic quartzite. These associated rocks are assigned to the Hardscrabble Mountain succession by (Struik, 1988), although some rocks in the western part of the belt may be upper Downey. This area was only examined briefly during the present study, and is designated as undivided Bralco/Hardscrabble on Figure 4.

Struik (1988) reports that a specimen of Bralco limestone from this belt, west of Roundtop Mountain, contains echinoderm fragments, suggesting a Paleozoic age. This is the only fossil control known within the entire Cariboo Lake - Wells study area.

## **HARVEYS RIDGE SUCCESSION**

Struik (1988) defined the Harveys Ridge succession to consist mainly of black and dark grey siltite, quartzite and



phyllite. He showed that it occurred stratigraphically above the Keithley and Ramos successions, and was in turn overlain by a variety of units, including the Goose Peak, Eaglesnest and Downey successions. Ferri (2001) showed that the Downey succession is overturned where it occurs structurally above the Harveys Ridge succession east of Cariboo Lake, suggesting that the Downey is actually stratigraphically beneath the Harveys Ridge and equivalent to the Keithley and Ramos successions. Ferri (2001) also introduced the term “Harveys Ridge transitional” for thick sections in which typical Harveys Ridge rocks are intercalated with feldspathic grits and quartzites similar to those of the overlying Goose Peak succession.

Here we use Harveys Ridge in an expanded sense that includes both the Harveys Ridge and Harveys Ridge transitional units of Ferri (2001). This succession dominates an extensive belt, flanked on both sides by older rocks of the Downey succession, which extends from Cariboo Lake to Highway 26. The Harveys Ridge succession is also mapped on the west side of the western Downey belt in the vicinity of Cariboo Lake. The rocks mapped as Harveys Ridge on Figure 4 include both the Harveys Ridge succession of Struik (1988), and extensive belts of rock mapped by Struik as undifferentiated Snowshoe Group. Struik noted that most of these undifferentiated rocks belonged to the Harveys Ridge through Eaglesnest part of his Snowshoe Group stratigraphy, in accord with the interpretation presented here.

The Harveys Ridge succession, as mapped here, consists mainly of medium to dark grey, locally black or light grey, quartzite and grit intercalated with variable proportions of dark grey to black siltite and phyllite. The siltite and phyllite are lithologically identical to those of the Hardscrabble Mountain succession, and mapping at a more detailed scale than that of Figure 4 could likewise present some of the more extensive occurrences as separate mappable units. The base of the succession corresponds to a change from predominantly light coloured rocks of the Downey, mainly in shades of green to grey-green, to grey rocks that invariably include significant dark grey to black varieties. Commonly the contact is marked by a thin unit of black quartzite that forms the base of the Harveys Ridge succession. The upper contact is harder to define as light and medium grey grits and quartzites, together with dark to black grey siltite and phyllite, are commonly interbedded over substantial intervals. Thus the base of the overlying Goose Peak succession is somewhat arbitrarily defined, but is placed where light grey grit and quartzite predominate over darker varieties, and interbedded phyllite and siltite are only a minor component of the succession.

Although clastic rocks predominate, the Harveys Ridge succession locally includes carbonate and volcanic rocks. Dark grey limestone is apparently widespread, but forms local thin units that make up a very small proportion of the succession. Mafic to intermediate volcanic and volcanoclastic rocks locally form substantial thicknesses, but seem to be common only around Cariboo Lake. These volcanic rocks are described by Ferri (2001) and Ferri and O’Brien (2002).

## AGNES CONGLOMERATE

Relatively thin units of quartzite-clast conglomerate within the Snowshoe Group were mapped as Agnes conglomerate by Struik (1988), who considered them a lateral equivalent of the Goose Peak succession. The conglomerate units around Cariboo Lake were also mapped by Ferri (2001) and Ferri and O’Brien (2002) who thought they were internally within the Harveys Ridge succession. Conglomerate units encountered during the 2002 mapping program were mainly within the Harveys Ridge succession, but similar conglomerate occurs locally in rocks we assign to the Goose Peak succession.

Most of the mappable units of Agnes conglomerate shown on Figure 4 are after Struik (1988) and Ferri and O’Brien (2002). The one north of Mount Agnes was encountered during our 2002 mapping. It comprises more than 50 metres of section that is about 50 percent pebble conglomerate, as beds or lenses ranging from a few tens of centimeters to almost 10 metres thick. The conglomerate beds are intercalated with intervals of mainly dark grey phyllite, siltite and sandy phyllite. The flattened clasts are mainly light to dark grey fine-grained quartzite, but also include pink quartzite and medium to dark grey siltite, as well as minor phyllite and vein quartz. The conglomerate matrix varies from phyllitic to sandy, and in some beds changes from one to the other along strike.

## GOOSE PEAK SUCCESSION

Struik (1988) assigned predominantly coarse-grained feldspathic quartzite and grit that crops out discontinuously along or near the trace of the Lightning Creek antiform between Cariboo Lake and Mount Agnes to the Goose Peak succession. Northwest of Mount Agnes he mapped a more continuous unit of quartzite, phyllite and grit, which he assigned to the Eaglesnest succession, in the core of the antiform. Struik thought that both the Goose Peak and Eaglesnest successions were stratigraphically above the Harveys Ridge succession; and that in the small area of overlap near Mount Agnes the Eaglesnest was above the Goose Peak.

Traverses across Struik’s (1988) Eaglesnest succession between Mount Agnes and Highway 26 suggest that parts of the succession, including dark grey to greenish-grey phyllite and siltite with intercalations of light to dark grey phyllitic quartzite and grit, should be included within the Harveys Ridge (transitional) unit. The remaining part is dominated by thin to thick-bedded light grey phyllitic quartzite and feldspathic grit, commonly with thin partings or interbeds of medium to dark grey phyllite and siltite. Also within this succession are units of relatively pure, light grey quartzite, and local lenses of conglomerate comprising flattened light grey quartzite clasts within a matrix of dark grey phyllite. This part of Struik’s (1988) Eaglesnest succession, as well as similar rocks mapped at the headwaters of the Swift River to the south, are here correlated with the Goose Peak succession (Figure 4). They, together with Goose Peak exposures mapped farther southwest at the head of Cunningham Creek by Struik (1988), form a discontinuous belt that follows the trace of the Light-

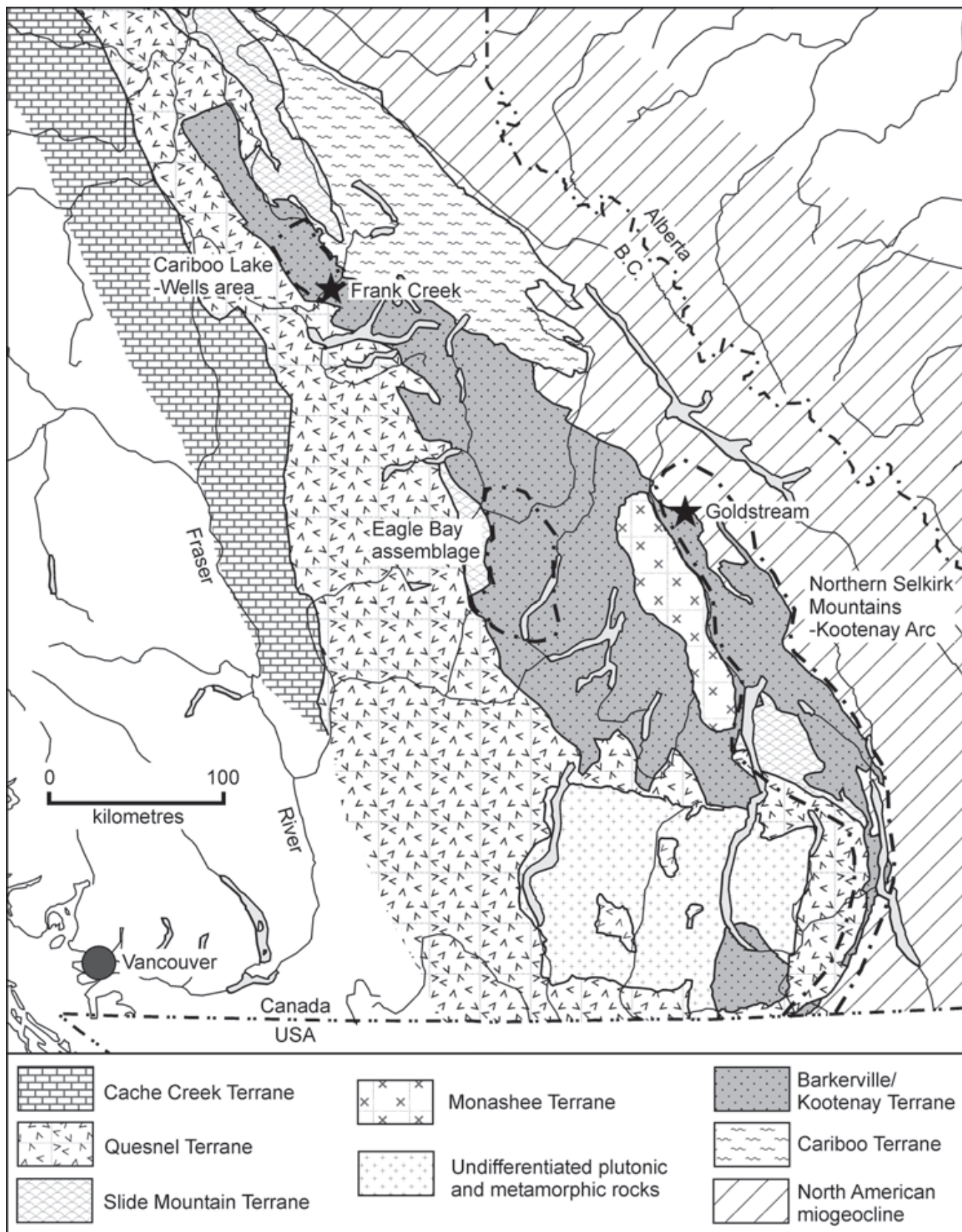


Figure 6. Terrane map of southern British Columbia showing the distribution of Kootenay/Barkerville terrane, and the general locations of the stratigraphic sections correlated in Figure 7.



ning Creek antiform. Farther south, directly north of Cariboo Lake, the Goose Peak succession is represented by two separate belts on the opposing limbs of the antiform (Ferri and O'Brien, 2002; Figure 4).

The Goose Peak succession is also mapped in the southwestern corner of the map area, west of the Keithley thrust (Figure 4). There it is represented by sparse exposures of feldspathic grit and quartzite that overlie the Harveys Ridge succession and are apparently intruded by Early Mississippian granitic rocks (Ferri and O'Brien, 2002).

## REGIONAL CORRELATIONS

Struik (1986) suggested that the Barkerville Terrane (Snowshoe Group) could be correlated with the Kootenay Terrane of southern British Columbia, and specifically with the well-studied stratigraphic succession of the Kootenay Arc and contiguous northern Selkirk Mountains, as well as with rocks included in the Eagle Bay assemblage near Adams Lake (Figure 6). Most subsequent workers have agreed that Barkerville and Kootenay terranes are essentially one and the same, but have proposed a variety of different corre-

lations for specific units of the Snowshoe Group (eg. Höy and Ferri, 1998; Höy, 1999; Ferri and O'Brien, 2002). The revised stratigraphic interpretation of the Snowshoe Group presented here requires a new set of correlations, which we show in Figure 7. The stratigraphy of the lower and middle parts of the Eagle Bay assemblage depicted in Figure 7 is after Schiarizza and Preto (1987), while the stratigraphy of the northern Selkirk Mountains and north end of the Kootenay Arc is from Colpron and Price (1995) and Logan *et al.* (1996).

Struik (1986) correlated the Keithley quartzite with other clean quartzite units in the region that define the contact between underlying Hadrynian rocks and overlying Paleozoic successions. We agree with this interpretation as it also provides compelling regional correlations for rocks above and below the quartzite. In the northern Selkirk Mountains, clean lowermost Cambrian quartzite that we correlate with the Keithley quartzite comprises the upper unit of the Hamill Group. Underlying portions of the Hamill Group are mainly quartzites and phyllites that therefore correlate with the Downey succession (including Struik's Keithley Creek and Ramos successions). The Hamill Group does not contain carbonates such as those

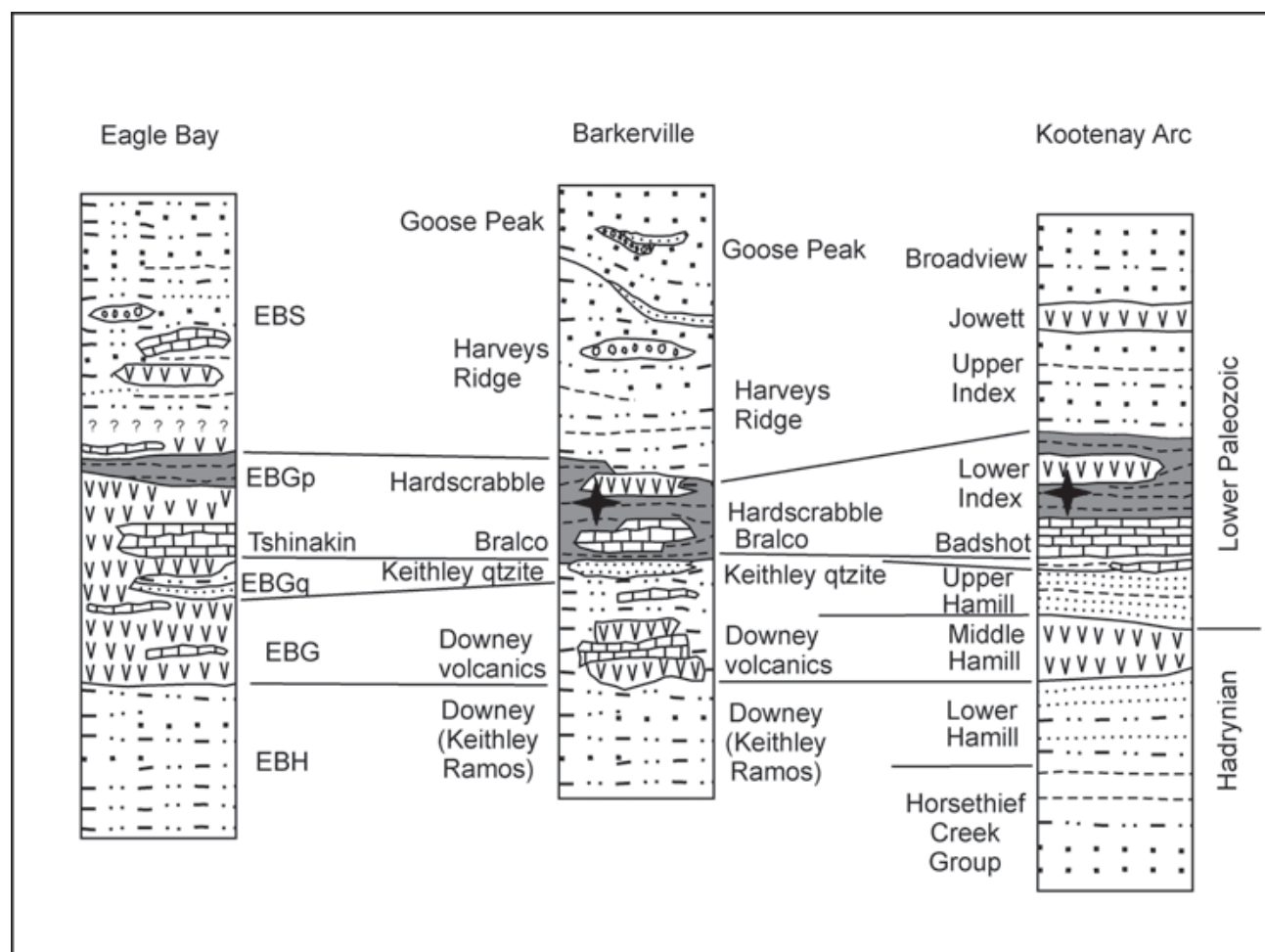


Figure 7. Schematic stratigraphic sections and proposed correlations for the Snowshoe Group, the Eagle Bay assemblage and the northern Selkirk Mountains/Kootenay Arc. Stars indicate the locations of the Frank Creek and Goldstream massive sulphide occurrences in the Snowshoe Group and Northern Selkirk Mountains sections, respectively.

found in the Downey succession, but the middle Hamill does include a substantial mafic volcanic component that may correlate with the volcanic rocks of the Downey (Devlin, 1988). The Hamill volcanics have yielded a latest Hadrynian U-Pb zircon date of  $569.6 \pm 5.3$  Ma (Colpron *et al.*, 2002). The clean quartzite at the top of the Hamill is overlain by the archaeocyathid-bearing Badshot limestone, which we correlate with the Bralco limestone. The Badshot is in turn overlain by the Index Formation of the Lardeau Group, the lower unit of which comprises black phyllite that is readily correlated with the Hardscrabble Mountain succession and correlative facies within the Harveys Ridge succession. This correlation is enhanced by the presence of mafic volcanic rocks within the lower Index that may correlate with the Harveys Ridge volcanics. In the northern Selkirk Mountains, black phyllite of the lower Index Formation is overlain by quartzite, phyllite, grit and minor carbonate of the upper Index, mafic volcanic rocks of the Jowett Formation, and an upper grit-dominated package assigned to the Broadview Formation (Figure 7). The Jowett Formation is not apparently represented in the Snowshoe Group, but the upper Index and Broadview formations are reasonably correlated with the Harveys Ridge transitional and Goose Peak successions, respectively.

Figure 7 shows only the lower and middle parts of the Eagle Bay assemblage. The upper part comprises Devonian-Mississippian felsic to mafic volcanic rocks and clastic sedimentary rocks that are not apparently represented in the Snowshoe Group, although Struik (1986) suggested that the Hardscrabble Mountain succession might correlate with Mississippian clastic rocks within the upper package. The lower part of the Eagle Bay assemblage differs from the Snowshoe Group and Kootenay Arc successions in that it contains a much higher proportion of mafic volcanic rocks. These mafic volcanics dominate a heterogeneous package assigned to Unit EBG by Schiarizza and Preto (1987). The Tshinakin limestone is a discontinuous but commonly very thick carbonate unit within this mafic volcanic succession; it contains Lower Cambrian archaeocyathids at one locality and therefore correlates with the Badshot Formation of the Kootenay Arc and probably with the Bralco limestone of the Snowshoe Group. A discontinuous but widespread sedimentary succession beneath the Tshinakin invariably includes a unit of very pure quartzite (Unit EBGq) that is here correlated with the Keithley quartzite. Underlying rocks comprise limestone intercalated with mafic volcanics and may correlate with the mafic volcanic/limestone intervals found within the Downey succession. This lower part of Unit EBG is gradationally underlain by grey to green quartzites, phyllites and grits (Unit EBH) that are similar to, and here correlated with, the typical clastic rocks of the Downey succession (Figure 7). The upper part of Unit EBG, above the Tshinakin limestone, includes a continuous unit of black phyllite, with local intercalations of dark grey limestone and quartzite (Unit EBGp), that we correlate with the Hardscrabble Mountain/Harveys Ridge succession of the Snowshoe Group and the lower Index Formation of the Lardeau Group. If this is the case, then the mafic volcanic rocks of Unit EBG may actually represent two or more

pulses of volcanism that correlate with Downey and Hamill volcanics at the base of the unit, and with Index and Harveys Ridge volcanics at the top of the unit (Figure 7).

The upper part of Unit EBG is truncated by a thrust fault in some areas and by a suspected unconformity beneath Devonian-Mississippian rocks in others, so the stratigraphic top of the unit is not well understood. Elsewhere within the Eagle Bay exposure belt, however, is a heterogeneous unit dominated by phyllitic grits, quartzites and subordinate phyllites, that also underlies Devonian-Mississippian rocks and is suspected to be younger than Unit EBG. This unit (Unit EBS of Schiarizza and Preto, 1987) is lithologically similar to, and tentatively correlated with, the Harveys Ridge transitional and/or Goose Peak successions of the Snowshoe Group (Figure 7).

## INTRUSIVE ROCKS

### EARLY MISSISSIPPIAN GRANITE

Foliated granite to granodiorite, locally grading to orthogneiss, crops out in the southwestern corner of the map area, south and west of the west end of Cariboo Lake (Figure 4). These rocks intrude the Harveys Ridge succession, and locally form the footwall to the Eureka thrust fault. Ferri and O'Brien (2002) show that the main granitic exposures comprise a transgressive sill-like body that is folded by a late upright synform. The granitic rocks are assigned an Early Mississippian age on the basis of a U-Pb zircon date of  $357.2 \pm 1.0$  Ma obtained by Ferri *et al.* (1999).

The Early Mississippian granite near Cariboo Lake is at the north end of a discontinuous belt of similar intrusions that extends for more than 100 kilometres southeastward within western Barkerville Terrane (Mortensen *et al.*, 1987). Similar Devonian-Mississippian granitic rocks are also found in the correlative Kootenay Terrane farther south, where they are in part associated with apparently co-magmatic Devonian-Mississippian volcanic rocks of the Eagle Bay assemblage (Schiarizza and Preto, 1987). Ferri *et al.* (1999) suggest, on the basis of geochemistry, that the Early Mississippian granitic rocks near Cariboo Lake are the products of arc magmatism.

### PROSERPINE INTRUSIONS

Johnston and Uglow (1926) introduced the term "Proserpine sills and dikes" for a suite of altered and foliated felsic intrusions found locally within rocks now assigned to the Snowshoe Group in the Antler Creek - Barkerville area. Rocks that probably belong to this suite were encountered in a few localities near Barkerville during the course of the 2002 mapping program, within rocks of the Downey, Hardscrabble Mountain and Harveys Ridge successions. These rocks comprise moderately foliated, brown-weathering quartz-feldspar-ankerite-sericite schists and semischists, in which feldspar and/or quartz were in part derived from relict igneous phenocrysts. One exposure of sericite-feldspar-quartz semischist within the upper part of the Downey succession near the head of Stouts Gulch displays hints of relict texture that suggest it was derived from an equigranular, medium-grained granitic rock. The



Proserpine intrusions are not dated, but this rock bears some similarity to the Early Mississippian granitic rocks near Cariboo Lake, suggesting that the two suites may, at least in part, be related. A sample of the foliated granitoid rock at the head of Stouts Gulch has been submitted for U-Pb dating of zircons in an attempt to determine its age. The results are not yet available.

## METADIORITE

Medium to dark green variably foliated metadiorite, grading to feldspar-chlorite schist, is scattered widely within the Snowshoe Group, but typically forms sills, dikes and irregular intrusive masses that measure only a few metres to tens of metres in size. Metadiorite is most common in the Downey succession, but is also found in other units of the group. The largest body of diorite in the region forms a mappable sill-like unit, up to several hundred metres thick, that intrudes the Downey succession near Mount Barker, east of Cariboo Lake (Ferri and O'Brien, 2002). Ferri and Friedman (2002) report U-Pb zircon dates from two separate samples of this large diorite unit, and another date from a diorite sill that intrudes the Harveys Ridge succession southwest of Keithley Creek. The samples from the diorite body near Mount Barker yielded dates of  $277.3 \pm 4.8$  Ma and  $281.0 \pm 5.2$  Ma, respectively, and the sill southwest of Keithley Creek yielded a similar date of  $281 \pm 12$  Ma. It is suspected that most other metadiorite bodies within the Snowshoe Group are of similar Early Permian age.

## STRUCTURE

### MESOSCOPIC STRUCTURES

Most rocks within the study area are at lower (sub-biotite) greenschist facies metamorphic grade. The mesoscopic structure is dominated by a synmetamorphic cleavage that is axial planar to northwest or southeast plunging mesoscale folds of bedding (Photo 1). This cleavage is penetrative within slates and phyllites, but is typically less pervasive within metasandstones and coarser rocks. It is commonly accompanied by a stretching or rodding lineation that is approximately parallel to the axes of the associated folds (Photo 2). This synmetamorphic cleavage and associated structures are related to predominantly southwest-vergent macroscopic folds that commonly form the dominant map-scale structures within the Snowshoe Group.

Locally it is apparent that the dominant synmetamorphic cleavage within the area is a composite fabric element that overprints, or is parallel to, one or more earlier bedding-parallel cleavages. These earlier cleavages are typically only evident in the hinge zones of folds, where they are folded and cross-cut at a high angle by the predominant cleavage. No folds were observed to be associated with these earlier cleavages, although relationships documented in the underground mines at Wells suggest that such structures might exist (Robert and Taylor, 1989; Rhys and Ross, 2001). Studies elsewhere in the region suggest that



Photo 1. Recumbent fold in the Harveys Ridge (transitional) succession, Jack of Clubs Creek. View is to the west-northwest.



Photo 2. Strong linear fabric in folded siltite of the Hardscrabble Mountain succession, south of Wells.

these early fabric elements within the Snowshoe Group are related to Early Jurassic east-directed overthrusting by the Quesnel Terrane (Ross *et al.*, 1985; Rees, 1987; Ferri, 2001), and/or to an earlier deformation event that affected the Snowshoe Group after intrusion of Early Mississippian granitic rocks (Ross *et al.*, 1985; Phillipone and Ross, 1990; McMullin *et al.*, 1990).

In most exposures in the map area, the dominant synmetamorphic cleavage is cut by one or two generations of younger structures. Most common is a single crenulation cleavage that dips steeply to the northeast or southwest (Photo 3). The associated crenulation lineations and upright mesoscopic folds plunge gently to the northwest or southeast, more or less parallel to the older fold axes and lineations. Locally, this steeply-dipping crenulation cleavage overprints an intermediate generation of folds that also deform the dominant synmetamorphic cleavage. These mesoscopic folds are most common in the area between Lightning and Barkerville, where they are typically tight and asymmetric, with vergence to the south-southwest. The



Photo 3. Upright crenulation cleavage cutting phyllitic cleavage, Harveys Ridge succession east of Lightning Creek.

fold axes, together with an associated crenulation lineation, plunge gently to the west-northwest or east-southeast, and the north-northeast-dipping axial surfaces are commonly followed by narrow quartz veins.

## MAP-SCALE STRUCTURES

Our interpretation of the macroscopic structure of the map area is summarized in the schematic vertical cross-sections of Figure 5. The distribution of geologic units within the Snowshoe Group is controlled by a large southwest-vergent nappe structure (Ferri and O'Brien, 2003) that is folded across the younger, upright, Lightning Creek antiform. The Downey succession forms the core of the early recumbent anticline. The axial trace of this structure had previously been recognized within the eastern belt of Downey rocks, because the Hardscrabble Mountain succession occurs on both sides of the Downey succession (Struik, 1988). Furthermore the western part of the Downey succession in this belt has long been known to be overturned on the basis of detailed work in the Well mining camp (Benedict, 1945; Skerl, 1948), where bedding/cleavage relationships and fold asymmetry show that the structure is related to formation of the regional synmetamorphic cleavage. The interpretation that this fold is actually the root zone of a large nappe, however, is based on the revised stratigraphic interpretation presented here, and in particular the interpretation that the Downey succession (together with flanking Hardscrabble Mountain/Harveys Ridge successions) is repeated to the west, in part as rocks that had previously been mapped as Keithley succession (Figure 4). Struik (1982) inferred similar recumbent fold structures based on a preliminary stratigraphic interpretation that correlated the Harveys Ridge and Hardscrabble Mountain successions; his later cross sections (*e.g.* Struik, 1988) do not show such structures because he subsequently interpreted the Hardscrabble Mountain succession to be younger than the Harveys Ridge (Figure 2).

Stratigraphic symmetries within the Harveys Ridge succession and associated rocks north of Cariboo Lake sug-

gest that the hinge of the associated syncline structurally beneath the anticlinal nappe breaches the topographic surface in that area. The synclinal hinge apparently closes to the north, around the axial trace of the late antiform, reflecting a gentle northward plunge of the antiform (Figures 4 and 5).

The recumbent, southwest-vergent fold pair interpreted to be the dominant structural feature of the map area is related to the main synmetamorphic cleavage within the area, and is suspected to be early Middle Jurassic in age (Mortensen *et al.*, 1987). These folds are correlated with similar southwest-vergent folds and nappes, of known or suspected Middle Jurassic age, that have been documented throughout much of Barkerville and correlative Kootenay terrane (Raeside and Simony, 1983; Ross *et al.*, 1985; Schiarizza and Preto, 1987; Brown and Lane, 1988). Many of these folds have overturned limbs comparable in size to the structure inferred here.

The most conspicuous map-scale structure of the area is the Lightning Creek antiform, which extends from Cariboo Lake northwestward to beyond the limits of the present map area (Struik, 1988). The axial trace of the fold separates predominantly northeast-dipping bedding and synmetamorphic cleavage on its northeast limb from predominantly southwest dipping orientations to the southwest. Although it is clearly an antiform, the fold contains the youngest units of the Snowshoe Group in its core because it is superimposed on the overturned limb of the older southwest-vergent nappe structure. As shown in Figure 5, the antiform is a well-defined open fold in the southeast, but becomes a broad arch to the northwest. The antiform is thought to be the same age as the steeply-dipping crenulation cleavage that is a common mesoscopic fabric element in the area. Other structures that may be the same age include an open synform west of Keithley Creek (Figure 4), and upright folds that repeat and warp the overturned Downey/Hardscrabble contact southwest of Wells (Figure 5, section A).

The Keithley thrust fault (Struik, 1988) is preserved in the core of the late synform west of Keithley Creek (Ferri and O'Brien, 2002; Figure 5, section C). The fault carries biotite and garnet-bearing rocks tentatively correlated with the Downey succession, and places them above younger Harveys Ridge and Goose Peak successions that are at lower metamorphic grade. Ferri and O'Brien (2002) describe highly deformed rocks along the eastern trace of the thrust, suggesting the presence of a large ductile shear zone. The movement direction along the thrust is unknown. In Figure 5 it is shown to root to the east, beneath the Pleasant Valley thrust, but alternatively it might be related to the Eureka thrust to the west. A system of thrust faults and ductile shear zones has also been mapped north of Wells, placing the Crooked amphibolite and Tom succession of Struik (1988) above the Downey succession. Like the Keithley thrust, these faults carry rocks that are, at least in part, at higher metamorphic grade than the footwall rocks. The significance and origin of these ductile shear zones and higher grade rocks in the upper structural levels of Barkerville Terrane has not been addressed.



## MINERAL OCCURRENCES

Bedrock mineral occurrences in the study area, extracted from the B.C. Geological Survey Branch's MINFILE database, are shown in Figure 8. Most are quartz veins, containing variable amounts and combinations of pyrite, galena, cosalite, sphalerite and scheelite, that have been explored for gold. In the Wells mining camp, pyritic replacement bodies in limestone are associated with the gold-quartz veins and have contributed substantially to the gold production. Massive sulphide occurrences in the Harveys Ridge succession around Cariboo Lake are relatively recent discoveries that are currently being explored by Barker Minerals Ltd. Stratabound lead-zinc and bedded barite showings in rocks that belong to the upper Downey or overlying Hardscrabble Mountain succession along upper Cunningham Creek may be sedimentary exhalative deposits (Höy and Ferri, 1998).

## MASSIVE SULPHIDE OCCURRENCES

Massive sulphide mineralization is represented in the present study area by the Frank Creek occurrence and nearby Big Gulp and Unlikely showings, all within the Harveys Ridge succession near the southwest end of Cariboo Lake. The Besshi-style mineralization and host rocks are described by Höy and Ferri (1998), Ferri (2001) and Ferri and O'Brien (2002). Here, we point out that the regional correlations presented in Figure 7 show that the host rocks to the Frank Creek occurrence correlate with rocks that host Besshi-style massive sulphide mineralization at the past-producing Goldstream deposit in the northern Selkirk mountains (Höy, 1979; Logan and Colpron, 1995).

## LODE GOLD OCCURRENCES

Almost all of the historic lode-gold production in the area has come from the Cariboo Gold Quartz, Island Mountain and Mosquito Creek mines of the Wells Mining camp (Figure 8). These three mines produced a combined total of 1.23 million ounces of gold from 3.03 million tons of ore between 1933 and 1987 (Hall, 1999). International Wayside Gold Mines Ltd. started exploring the Wells – Barkerville area in 1994 and discovered the Bonanza Ledge zone in March 2000. The zone is about 2 kilometres southeast of the main workings of the Cariboo Gold Quartz mine, although the B.C. vein, structurally above the zone, was accessed by an underground extension of the mine's main haulage level in 1941. A recent resource estimate by Giroux Consultants Ltd. of Vancouver shows indicated resources of 372 000 tons grading 0.239 oz/ton Au in Bonanza Ledge and 326 000 tons grading 0.155 oz/ton Au in the B.C. vein, using a 0.02 oz/ton cutoff. Inferred resources, using the same cutoff, are 44 000 tons grading 0.179 oz/ton Au in Bonanza Ledge and 321 000 tons grading 0.070 oz/ton in the B.C. vein. An estimate for the nearby Cow Mountain zones (Cariboo Gold Quartz mine) made in 2000 showed indicated and inferred resources of 6 629 000 tons grading 0.065 oz/ton Au and 1 684 000 tons grading 0.054 oz/ton

Au, respectively. A scoping study is currently underway to examine the possibility of open-pit mining all three areas utilizing a central milling facility (Press Release by International Wayside Gold Mines Ltd., November 2002).

Detailed descriptions of the past-producing mines of the Wells camp are provided by Benedict (1945), Skerl (1948), Sutherland Brown (1957), Alldrick (1983) and Robert and Taylor (1989). Descriptions of the Bonanza Ledge zone are provided by Rhys and Ross (2001) and Ray *et al.* (2001). Historic gold production has come from two different types of ore: auriferous pyrite in quartz veins, and massive auriferous pyrite lenses, referred to as replacement ore, associated with limestone. The main producing vein systems (mainly Cariboo Gold Quartz mine) comprise diagonal and transverse veins adjacent to northerly striking faults. The overall geometry of the system, together with the structural characteristics of the two vein sets, suggest that the diagonal veins and north-striking faults are part of a conjugate fault system, and the transverse veins fill extensional fractures related to this system (Figure 9; Sutherland Brown, 1957; Rhys and Ross, 2001). The replacement ore (mainly Island Mountain and Mosquito Creek mines) occurs in carbonate-bearing stratigraphy that is structurally above (stratigraphically below) the main vein systems. It occurs within and adjacent to limestone units, commonly as linear bodies localized in the hinge zones of synmetamorphic folds. The fold hinges are perpendicular to the transverse (extensional) veins of the structurally lower vein-hosted ore, and ore-bearing veins are locally seen to extend into and terminate in replacement ore (Skerl, 1948; Alldrick, 1983).

Historic production from the Wells camp has come from a restricted stratigraphic range, and stratigraphy has consequently been an important guide to exploration in the area. The critical stratigraphic units are the Rainbow and Baker members of the Richfield formation, as defined by Hanson (1935). Most producing vein systems are in quartzites and phyllites of the Rainbow member, while replacement ore occurs in limestone bodies at or near the base of the structurally overlying (stratigraphically underlying) Baker member. As shown in Figure 10, both of these units are in the upper part of the Downey succession. The structurally underlying B.C. member of Hanson comprises the base of the Hardscrabble Mountain succession. Hanson's structurally lower Lowhee and Basal units are probably structural repeats of the Rainbow and B.C. members, respectively, as suggested by Skerl (1948).

The most prominent and continuous quartz veins in the Wells area, the so-called strike veins, are more or less parallel to the regional strike of the host strata, but dip more steeply. One of these, the B.C. vein, produced a modest amount of gold in the 1940s. Exploratory drilling on the B.C. vein led to the discovery of Bonanza Ledge, in the footwall of the vein, in March 2000. According to Rhys and Ross (2001) gold within the Bonanza Ledge zone occurs in discrete pyrite-rich areas within a zone of intense and pervasive sericite-iron carbonate-pyrite alteration that ranges from 20 to 100 metres wide. Gold-bearing zones are locally more than 30 metres thick and comprise veinlets, concor-

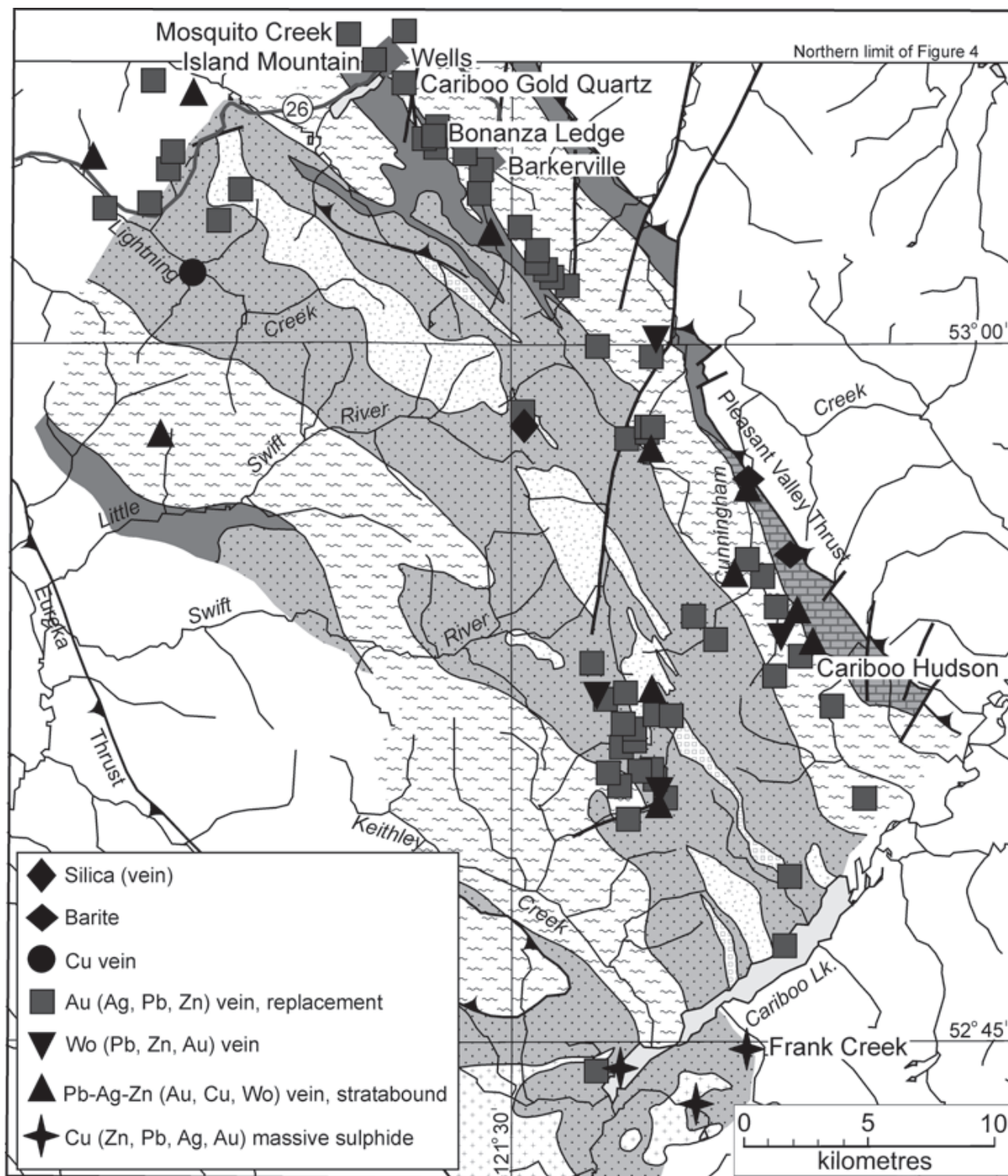


Figure 8. Locations of MINFILE occurrences in the Snowshoe Group, Cariboo Lake - Wells area.



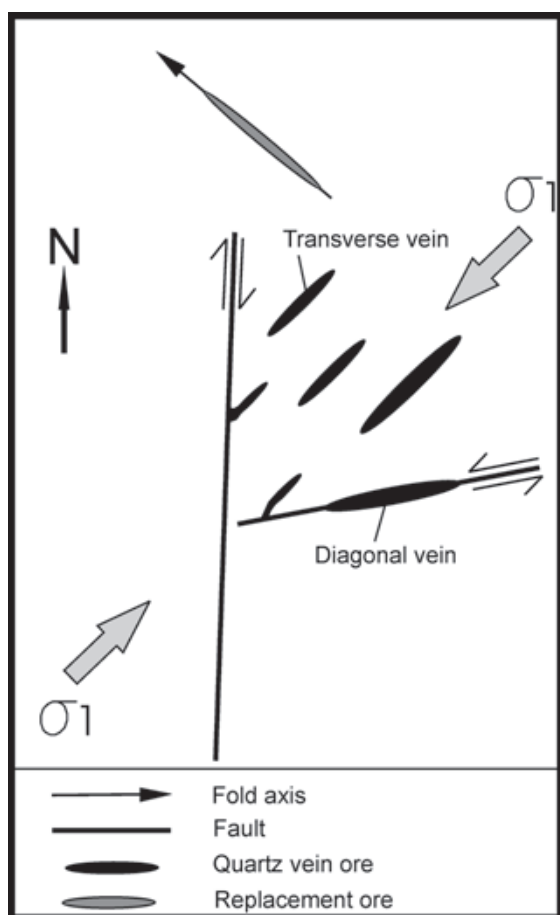


Figure 9. Schematic summary of the geometric relationships of ore-hosting veins and structures in the Wells mining camp, after Sutherland Brown (1957) and Rhys and Ross (2001).

dant laminations and massive bands of pyrite in a gangue of muscovite, dolomite/ankerite and quartz. Veinlets and pyrite bands are folded and locally elongated parallel to the fold axes. Rhys and Ross suggest that the mineralization and alteration style at Bonanza Ledge is similar to that associated with the replacement bodies that were historically mined in the Wells camp. However, the Bonanza Ledge bodies are larger, and structurally lower than the past-producing lodes (Figure 10) so present an important new exploration target.

On a regional scale, the Wells Mining camp is here interpreted to occur on the overturned limb of a large southwest-vergent nappe structure (Figure 5, section A). This structure is thought to be Jurassic in age, and a Jurassic component of deformation and metamorphism is corroborated by a whole rock K-Ar date of  $179 \pm 8$  Ma obtained from phyllite near Wells (Andrew *et al.*, 1983). Lead isotope data suggest that the gold has a host-rock upper crustal source (Andrew *et al.*, 1983) and may have been mobilized by prograde regional metamorphic fluids and then deposited in structurally higher and cooler parts of the orogen (Struik, 1988). The gold-bearing lodes of the Wells camp were deposited after the stratigraphy was overturned (given that the replacement deposits seem to be fed by the structurally underlying vein systems), but formed in a strain regime com-

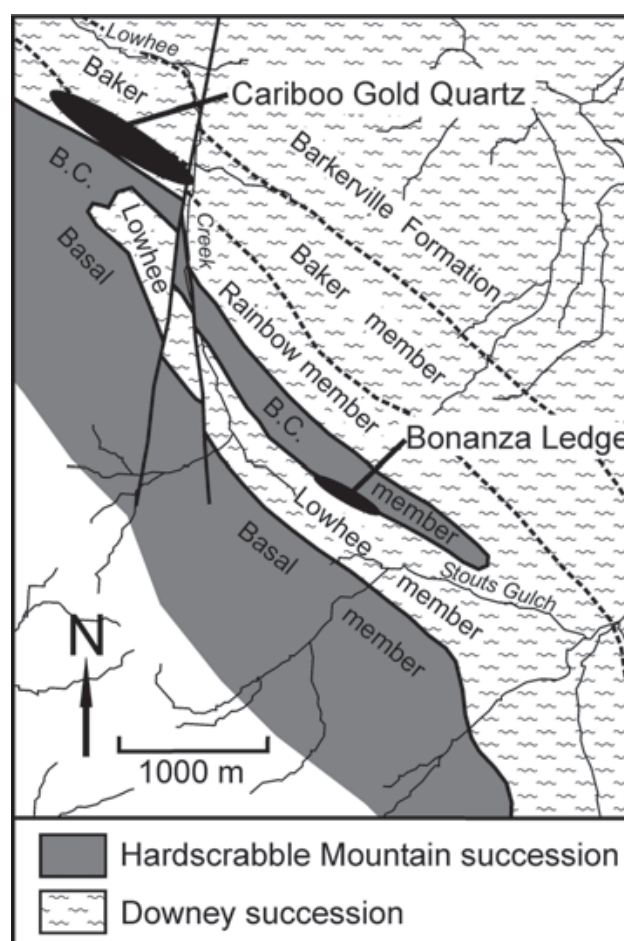


Figure 10. Geology of the Lowhee Creek – Stouts Gulch area, showing relationship between Hanson's (1935) stratigraphic units and the regional stratigraphy, as well as stratigraphic/structural position of Bonanza Ledge relative to past-producing lodes, as represented by the Cariboo Gold Quartz mine.

patible with the one that formed the main regional structures (Figure 9). The few K-Ar dates on muscovite from veins in and near the Wells camp cluster around 140 Ma (Andrew *et al.*, 1983; Alldrick, 1983; Hall, 1999). A similar Early Cretaceous age has been documented for regional metamorphism in the southern Cariboo Mountains (Digel *et al.*, 1998), and near the Barkerville/Cariboo terrane boundary at Hobson Lake this metamorphism is associated with southwest-vergent structures that overprint, and are not easily distinguished from, synmetamorphic southwest-vergent folds of Middle Jurassic age (P.S. Simony, personal communication, October 2002). It is suspected that a similar Early Cretaceous structural/metamorphic overprint may extend northwestward to the Wells-Barkerville area. This might explain some of the structural observations made by Robert and Taylor (1989) and Rhys and Ross (2001) that suggest there is more than one episode of synmetamorphic deformation within the Wells mining camp.

## SUMMARY OF MAIN CONCLUSIONS

Observations made during the 2002 mapping program are generally consistent with the revised stratigraphic interpretations presented by Ferri (2001) and Ferri and O'Brien (2002). The lowest stratigraphic unit of the Snowshoe Group is the Downey succession, which includes rocks previously mapped by Struik (1988) as Keithley and Ramos successions. The Downey is overlain by the Harveys Ridge succession, which includes the Hardscrabble Mountain unit as an internal mappable facies in its lower part, and the Agnes conglomerate as a mappable unit at higher stratigraphic levels. The Goose Peak succession is the highest stratigraphic element of the group and includes some rocks mapped by Struik as Eaglesnest succession.

The stratigraphic interpretation adopted here requires major across-strike repetitions of mappable units within the Snowshoe Group. We interpret this map pattern to reflect the presence of a major southwest-vergent nappe that is folded by the younger Lightning Creek antiform. The early fold nappe is correlated with southwest-vergent folds and nappes, of mainly Middle Jurassic age, that are a prominent feature of other parts of Barkerville/Kootenay terrane. The Lightning Creek antiform changes from an open fold in the southeast to a broad arch in the northwest, and contains the youngest rocks of the Snowshoe Group in its core. This otherwise enigmatic feature is explained by the presence of the older nappe since, at the present level of erosion, the antiform is developed in the overturned limb of the early structure.

The Keithley quartzite at the top of the Downey succession is correlated with the upper unit of the Hamill Group in the northern Selkirk Mountains and with Unit EBGq of the Eagle Bay assemblage. Underlying rocks of the Downey are correlated with the middle and lower units of the Hamill Group, and with the lower part of Unit EBG and underlying Unit EBH. The Bralco limestone, which overlies the Downey succession locally, is correlated with the Badshot Formation of the Northern Selkirks and the Tshinakini limestone of the Eagle Bay assemblage. The overlying Hardscrabble Mountain facies of the Harveys Ridge succession is correlated with prominent black phyllite units comprising the Lower Index Formation of the northern Selkirks and Unit EBGp of the Eagle Bay assemblage. The upper Harveys Ridge and Goose Peak successions are correlated with similar Paleozoic grit-bearing successions comprising the upper Index and Broadview formations of the northern Selkirks and Unit EBS of the Eagle Bay assemblage.

The regional correlations presented here show that the host rocks to the Frank Creek massive sulphide occurrence correlate with rocks that host Besshi-style massive sulphide mineralization at the past-producing Goldstream deposit in the northern Selkirk Mountains.

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